**Original Article**

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# Complications of Rib Fracture in Emergency Department Patients: A Cross-Sectional Analysis of Clinical Outcomes and Quality of Life

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## Abstract

**Introduction:** Rib fractures are a significant cause of morbidity and mortality in emergency medicine, particularly when associated with thoracic trauma. This study aimed to evaluate clinical outcomes, complication rates, and quality of life (QOL) in patients with rib fractures presenting to emergency departments in Tehran, Iran.

**Methods:** This analytical cross-sectional study was conducted from September 2024 to March 2025 at Hazrat Rasool and Shohada 7th Tir Hospitals, Tehran, Iran. A total of 200 patients with confirmed rib fractures were enrolled. Demographic data, injury mechanisms, clinical treatments, and complications were collected from medical records. QOL was assessed using the Short Form Health Survey 36 (SF-36) questionnaire at baseline and three-month follow-up. Recovery duration was defined as time to return to normal daily activities as reported by patients during follow-up visits or telephone interviews. Data were analyzed using SPSS software (version 26) and Pearson correlation analysis (significance level: $P<0.05$).

**Results:** Of 200 patients enrolled, 87.9% were male with mean age 51.7±16.8 years. Motor vehicle accidents (63.0%) and falls from height (22.5%) were the most common injury mechanisms. Mean number of fractured ribs was 2.45±0.80. Surgical stabilization was used in 23.5% of cases and physiotherapy in 58.0% (n=193). Pneumothorax (49.0%), hemothorax (34.0%), and pneumonia (11.0%) were the most frequent complications. In-hospital mortality was 3.5% overall and 7.4% in patients over 65 years. Recovery duration data were available for 21 patients, averaging 3.2±2.3 months. Pearson correlation analysis revealed moderate negative correlations between age and QOL ($r$=-0.40, $P<0.001$) and between the number of fractured ribs and QOL ($r$=-0.50, $P<0.001$). The presence of complications and prolonged recovery duration were strongly negatively correlated with QOL ($r$=-0.60 for each, $P<0.001$).

**Conclusions:** Rib fractures are associated with significant short-term and long-term morbidity, particularly in elderly patients and those sustaining multiple fractures. The strong negative associations between injury severity (number of ribs, complications) and QOL emphasize the need for aggressive pain management and rehabilitation strategies to optimize patient outcomes.

**Key words:** Complications, Emergency department, Quality of life (QOL), Rib fractures, Thoracic trauma

## Introduction

Rib fractures are a significant public health concern in emergency medicine, particularly following high-energy thoracic trauma, such as motor vehicle collisions. These injuries account for a substantial proportion of hospitalizations related to traumatic thoracic injury and are strongly associated with morbidity and mortality (1,2).

Rib fractures lead to a complex range of constellation of complications whose severity depends on multiple factors, including the mechanism of fracture, the number of ribs involved, the degree of rib displacement, the presence of associated thoracic injuries, and the patient's overall health status. The significance of rib fractures lies not only in their immediate physiological consequences but also in their profound impact on long-term quality of life (QOL) and functional recovery (1,2).

Complications of rib fractures are particularly concerning with multiple fracture involvement, which significantly impairs healing and predisposes patients to serious complications, such as pneumonia, hemothorax, pneumothorax, and pulmonary contusion (3,4). Epidemiological data demonstrate that the number of fractured ribs is directly proportional to morbidity and mortality rates. Mortality increases exponentially with fracture number: approximately 5% for one to two ribs, 15% for three to five ribs, and 34% for six or more ribs. Displaced rib fractures are especially strong predictors of complications because they can cause direct trauma to adjacent structures, including the intercostal vasculature and lung parenchyma (7,8).

Pain management and respiratory mechanics are critical challenges in rib fracture patients. Severe pain from rib fractures limits effective coughing and deep breathing, predisposing to pulmonary complications, such as atelectasis, hypoxemia, and pneumonia. Age is a crucial prognostic factor; elderly patients with rib fractures experience higher complication rates and mortality due to diminished pulmonary reserve and reduced healing capacity (5,6).

The management of rib fractures has evolved significantly in recent years, with increasing recognition of the role of multimodal pain control, aggressive pulmonary hygiene, and in selected cases, surgical stabilization of severely displaced or multiple rib fractures (9-12). Despite advances in care, substantial gaps remain in our understanding of optimal management strategies and their impact on long-term outcomes, particularly regarding QOL and functional recovery.

This study was designed to evaluate clinical outcomes, complication rates, and QOL in patients with rib fractures presenting to the emergency departments of teaching hospitals in Tehran, Iran, to identify strategies to improve patient management and long-term functional outcomes.

## Methods

### *Study Design and Setting*

This was an analytical cross-sectional study conducted between September 2024 and March 2025 at the Emergency Departments of Hazrat Rasool and Shohada-e Haftom-e Tir Hospitals, Tehran, Iran. Both are tertiary-level teaching hospitals affiliated with Iran University of Medical Sciences, Tehran, Iran.

### *Study Population and Inclusion/Exclusion Criteria*

The inclusion criteria included age≥18 years, confirmed diagnosis of rib fracture(s) by computed tomography or radiography, and presentation to the emergency department within 72 hours of injury.

The exclusion criteria included age<18 years, severe head trauma requiring intensive care management, pre-existing neuropsychiatric disease that would preclude reliable QOL assessment, inability or unwillingness to provide informed consent, and pregnancy.

The rationale for excluding patients with pre-existing neuropsychiatric disease was to ensure reliable self-reporting of QOL measures and minimize confounding from baseline psychiatric conditions affecting QOL assessment.

A total of 200 patients met inclusion criteria and were enrolled in the study.

### *Data Collection*

Demographic information, injury characteristics, and clinical details were systematically collected from medical records during the initial emergency department visit and hospital admission. The following variables were recorded:

Demographic Variables:
- Age, sex, occupation
- Comorbid medical conditions

Injury Characteristics:
- Mechanism of injury
- Time from injury to presentation
- Number of fractured ribs
- Side of fracture (unilateral vs. bilateral)
- Presence and type of associated thoracic injuries

Treatment Modalities:
- Surgical stabilization of ribs
- Physiotherapy (yes/no)
- Analgesic management (type and duration)
- Supplemental oxygen requirements
- Mechanical ventilation (if applicable)

Outcomes and Complications:

- Pneumothorax (presence/absence, type: simple or tension)
- Hemothorax
- Pulmonary contusion
- Pneumonia (defined by clinical and radiological findings)
- Flail chest
- In-hospital mortality
- Length of hospital stay

Quality of Life (QOL) Assessment:

QOL was assessed using the validated Short Form Health Survey 36 (SF-36) questionnaire, administered at baseline (within 48 hours of presentation) and at three-month follow-up. The SF-36 yields eight subscale scores (physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health) and two summary scores (physical component score and mental component score). Scores range from 0 to 100, with higher scores indicating better QOL. The SF-36 has been validated in Iranian populations.

Recovery Duration:

Recovery duration was operationally defined as the time from injury to return to normal daily activities as self-reported by patients during follow-up visits or telephone interviews. This endpoint was selected to capture meaningful functional recovery from the patient perspective. Recovery duration data were collected during follow-up contact at three months post-injury; however, data were available for only 21 patients (10.5%), primarily due to loss to follow-up and incomplete documentation of recovery time in medical records. This represents a significant limitation, which is further addressed in the Discussion section.

### *Statistical Analysis*

Demographic and clinical characteristics were presented as means ± standard deviations for continuous variables (after assessment of normality using the Shapiro-Wilk test) or as frequencies and percentages for categorical variables. Correlation analysis between independent variables (age, number of fractured ribs, presence of complications, recovery duration) and the dependent variable (QOL scores) was performed using Pearson's correlation coefficient. A P-value<0.05 was considered statistically significant. All statistical analyses were conducted using SPSS software (version 26.0).

## Results

### *Demographic and Injury Characteristics*

A total of 200 patients with rib fractures were enrolled. Table 1 presents the baseline demographic and injury characteristics.

The cohort was predominantly male (87.9%, n=175), with sex data missing for one patient (n=199). Mean age was 51.7±16.8 years (range: 18-89 years). Motor vehicle accidents were the most common mechanism of injury (63.0%, n=126), followed by falls from height (22.5%, n=45) and direct blunt trauma (14.5%, n=29). The mean number of fractured ribs was 2.45±0.80 (range: 1-6 ribs; median: 2 ribs). Most fractures were unilateral (72.0%, n=144), with bilateral fractures in 28.0% of cases (n=56).

**Table 1.** Demographic Characteristics of Patients (n=200)

| Characteristic | No. (%) or Mean ± SD |
|---|---|
| **Sex** | |
| Male | 175 (87.9) |
| Female | 24 (12.1) |
| **Missing data** | 1 |
| **Age (y)** | 51.7 ± 16.8 |
| **Mechanism of injury** | |
| Motor vehicle accident | 126 (63.0) |
| Fall from height | 45 (22.5) |
| Direct blunt trauma | 29 (14.5) |
| Number of ribs fractured | 2.45 ± 0.80 |
| **Laterality of fractures** | |
| Unilateral | 144 (72.0) |
| Bilateral | 56 (28.0) |

### *Treatment Modalities*

Surgical stabilization of ribs was performed in 23.5% of patients (n=47). Physiotherapy was documented for 193 patients, of whom 58.0% (n=112) received physiotherapy as part of their treatment regimen. The denominator differed from the total sample (200) due to incomplete documentation of physiotherapy status in seven patients' records. All patients received appropriate analgesic management; types and duration of analgesia varied by clinical presentation and institutional protocols.

### *Complications and Outcomes*

Thoracic complications were frequent (Table 2).

Pneumothorax occurred in 49.0% of patients (n=98), hemothorax in 34.0% (n=68), and pulmonary contusion in 38.5% (n=77). Flail chest_defined as fractures in two or more adjacent ribs at two or more points, resulting in paradoxical movement_was present in 12.0% of patients (n=24). Pneumonia was documented in 11.0% of cases (n=22).

**Table 2.** Thoracic Complications and Clinical Outcomes

| Complication/Outcome | No (%) or Mean ± SD |
|---|---|
| **Pneumothorax** | 98 (49.0) |
| **Hemothorax** | 68 (34.0) |
| **Pulmonary contusion** | 77 (38.5) |
| **Flail chest** | 24 (12.0) |
| **Pneumonia** | 22 (11.0) |
| **In-hospital mortality** | |
| Overall | 7 (3.5) |
| Age>65 years | 5 (7.4) |
| Length of hospital stay (days) | 6.8±4.2 |
| **Recovery duration (n=21)** | 3.2±2.3 |

In-hospital mortality was 3.5% overall (n=7) and 7.4% (n=5 of 67) among patients aged>65 years. Mean length of hospital stay was 6.8±4.2 days (median, 6 days).

### *Quality of Life (QOL) Analysis*

QOL assessment using the SF-36 was obtained from patients at three-month follow-up. Correlation analysis revealed significant negative associations between injury and patient-related factors and QOL outcomes.

Correlation with Age: A moderate negative correlation was found between age and overall QOL scores (Pearson $r$=-0.40, P<0.001), indicating that older patients reported lower QOL at three-month follow-up.

Correlation with Number of Fractured Ribs: Number of fractured ribs demonstrated a stronger negative correlation with QOL ($r$=-0.50, P<0.001), suggesting that patients with multiple rib fractures experienced more substantial declines in QOL.

Correlation with Complications: The presence of complications (pneumothorax, hemothorax, pulmonary contusion) showed a strong negative correlation with QOL ($r$=-0.60, P<0.001). Patients experiencing thoracic complications reported significantly lower QOL scores.

Correlation with Recovery Duration: Among the 21 patients with available recovery data, longer recovery duration demonstrated a strong negative correlation with QOL ($r$=-0.60, P<0.001) (Table 3).

## Discussion

This cross-sectional study of 200 patients with rib fractures demonstrates the substantial burden of this injury on both acute outcomes and long-term QOL. The predominance of male patients (87.9%) and of motor vehicle accidents (63.0%) as the injury mechanism are consistent with epidemiological patterns reported in the international literature, reflecting higher rates of risk-taking behavior and occupational exposure among males (1,13).

The high incidence of complications is striking. Nearly half of patients (49.0%) sustained pneumothorax, and one-third (34.0%) developed hemothorax. These findings underscore the severity of injuries in this cohort and are consistent with reports from major trauma centers (14,15). The high frequencies of hemothorax and pneumothorax reflect direct trauma to the lung parenchyma and visceral pleura that occurs with multiple, displaced rib fractures.

The strong negative correlations between injury severity markers and QOL outcomes represent a critical finding with important clinical implications. The correlation between number of fractured ribs and QOL ($r$=-0.50) demonstrates that injury severity has a dose-dependent effect on functional recovery. This finding supports evidence-based interventions targeting pain management and pulmonary protection in patients with multiple rib fractures.

The very strong negative correlation between complication presence and QOL ($r$=-0.60) likely reflects multiple mechanisms beyond mere physical limitation. Patients with pneumothorax or hemothorax often require chest tube placement and prolonged hospitalization, which may contribute to psychological distress and deconditioning. Additionally, the presence of complications may necessitate extended analgesic requirements and limitation of mobilization, further impacting functional recovery (17,18).

The moderate negative correlation between age and QOL ($r$=-0.40) is consistent with literature documenting age-related differences in injury recovery. Older patients have reduced pulmonary reserve, slower wound healing, and increased susceptibility to pneumonia, all contributing to prolonged morbidity (19,20).

Surgical stabilization was employed in 23.5% of the cohort. Although, the current analysis does not provide detailed comparison of QOL outcomes between surgically and non-surgically managed

patients, the indication for surgery in this population likely reflects more severe injury patterns (greater number of ribs, greater displacement, flail chest). The association between surgical intervention and potentially lower QOL scores may reflect the greater baseline severity of these injuries rather than adverse effects of surgery itself. Future prospective studies with detailed stratification by injury severity and treatment approach would be valuable in clarifying optimal management strategies (21,22).

The study has several limitations. Its single-center design limits generalizability, and incomplete follow-up data restrict conclusions about recovery outcomes. The cross-sectional design prevents causal inference, while exclusion of patients with severe comorbidities may introduce selection bias. Additionally, missing data in some variables may affect result precision, and the use of the SF-36 alone may not fully capture trauma-specific functional outcomes. Future studies should employ multi-center, longitudinal designs with improved follow-up, broader inclusion criteria, standardized data collection, and complementary injury-specific assessment tools.

**Table 3.** Correlation Analysis Between Injury Severity Factors and Quality of Life (QOL) (SF-36)

| Variable | Pearson r | P-value | Interpretation |
|---|---|---|---|
| Age and QOL | -0.40 | <0.001 | Moderate negative correlation |
| Number of fractured ribs and QOL | -0.50 | <0.001 | Moderate-strong negative correlation |
| Presence of complications and QOL | -0.60 | <0.001 | Strong negative correlation |
| Recovery duration and QOL (n=21) | -0.60 | <0.001 | Strong negative correlation |
| Surgical stabilization and QOL | -0.35 | <0.01 | Moderate negative correlation |
| Physiotherapy and QOL | 0.28 | <0.05 | Weak positive correlation |

## Conclusions

Our findings highlight the multifaceted nature of rib fractures, underscoring the importance of carefully analyzing demographic variables and specific injury details in predicting clinical outcomes. The literature is in agreement with our findings, showing significant relationships between age, the number of fractures, and complications, such as pneumonia, thereby underscoring the need for medical professionals to adopt an aggressive approach in caring for patients with rib fractures.

## Ethics Approval and Consent to Participate

This research was approved by the Institutional Review Board at Iran University of Medical Sciences. All patients provided written informed consent prior to enrollment, and patient confidentiality was strictly maintained by the Declaration of Helsinki (Ethic code: IR.IUMS.FMD.REC.1402.282).

## Consent for Publication

Not applicable.

## Data Availability Statement

Data are available upon reasonable request from the corresponding author.

## Funding Statement

Iran University of Medical Sciences, Tehran, Iran

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None.

## Authors' Contribution

M.R. and P.H. conceptualized and designed the study. A.Z., N.T., and A.M.V. contributed to data collection and patient enrollment. M.Y. and A.J. performed data analysis and interpretation. A.J., as the corresponding author, supervised the study and coordinated the research process. M.R. drafted the initial manuscript, and all authors critically reviewed and revised the manuscript for important intellectual content. All authors approved the final version of the manuscript and take responsibility for the integrity of the work.

## Conflict of Interest

The authors declared no conflicts of interest.

## Declaration of Generative Artificial Intelligence (AI) in Scientific Writing

All scientific content, reasoning, and conclusions in this manuscript are the sole responsibility of the authors.

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